An Intelligent Crime System Using Internet of Things [IoT] and Web Technological Tools For Instance Crime Reporting and Notification

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Abstract- ***The aim of this research is to design an enhanced crime system using internet of things (IoT) and web technological tools while objective is to analyze the existing crime recording system in Nigerian security agencies, to provide a system that can track and monitor crime and criminalities on real time and a system for instance reporting of crime rate which will trigger immediate action by the law enforcement agencies of Nigeria. The motivation towards this study is the increase of insecurity witnessed in our dear state and country at large where the law enforcement agency of Nigeria finds it so difficult to track or monitor crime and criminals effortlessly. This study also was motivated in other to provide a system that can eradicate the manual process of crime reporting by the people and makes it easier for criminals to be tracked and identified remotely with the help of advanced technology. An object oriented analysis design methodology (OOADM) was employed for the system analysis, design and development of the proposed system which includes ARDUINO UNO platform, MySQL as backend database for storing criminal records together with hypertext preprocessor (PHP), hypertext markup language (HTML). These development tools were chosen because of their simplicity and flexibility in coding, easy integration and deployment and implementation of an online system. The results was able to provide the general public a platform to make report on a crime witnessed remotely, and also allow the law enforcement agencies like the police force easily track and monitor a victim of crime or crime scene through the help of the general public crime report and picture upload which can be monitored and instance alert notification to the police patrol team for instance action.***

Indexed Terms- ***Internet of Things, Crime System, Instance Online Crime notification, Intelligent Crime Response Platform.***

I. INTRODUCTION

A crime is an act of wrongdoing that merit community condemnation and punishment usually by way of payment of fine or imprisonment [1]. There are numerous examples of crime, but this study is confined to Rape, Armed Robbery, Murder, Kidnapping, and Ritual Killings, which are more prevalent in Nigeria [2]. Rate of crime is inversely proportional to the rate of economic development of any nation [3]. This implies that no nation can experience any meaningful development with a high rate of crime. Hence, it is imperative for the government of any nation to curtail or eradicate this monster from the society. Crime analysis is a methodical approach for identifying and analyzing patterns and trends in crime. With the increasing origin of computerized systems, crime data analysts can help the Law enforcement officers to speed up the process of solving crimes.

Because of the increased crime rate over the years, one will have to handle a huge amount of crime data stored in warehouses which would be very difficult to be analyzed manually, and looking at the advancement being applied by todays criminals, there is need to use advance technologies in order to keep police ahead of them. In this study, the main aim is to design an enhanced crime system using internet of things (IoT) technologies providing an online accessibility for users remotely. As reported by [4], the word Internet of Things was first used by Kevin Ashton in 1998 presentation. As stated by [5], Internet of Things (IoT) has the potential to change

the world, just as the Internet while during 2001; MIT AutoID Lab center presented their view on IoT. Then during 2005, IoT was formally recognized by the International Telecommunication Union (ITU). Nevertheless, IoT has created a world where all the objects (also called smart objects) around our environment could be connected to the Internet and communicate with each other with minimum human intervention. The crucial objective is to create a better world for humans', an environment where objects around us know what we like, what we want, and what we need and act accordingly without explicit instructions. Currently most researches are focusing on how to provide a smart system using IoT that could enable objects around us to understand our feelings, hear and smell the physical world by them remotely and make them connected to share the observations [6]. With these new features, it will be easier for object monitoring and decision making from the human side to the machine side and same time enable our security agencies monitor and trace crime at the snap of their fingers using smart technologies as an alert tools. It is not a news today that application of technology has change the way one does things especially the introduction of IoT, scholars over the world has used IoT to design and solve difficult problems that are hard to achieve. The lack of reliable central case recording database for security agencies means that cases were impossible to be traced without considerable resources, effort and a lot of luck. Without a crime profiling system, the detective is less likely to build the complete picture from bits of information from different crime incidents. Today most of it is manually done with the help of multiple spreadsheet reports that the detectives usually get from the computer data analysts and their own crime logs and make it difficult to identify crime and the victims. This age long practices has restricted the security agencies from identifying crime prone areas and periods it normally takes place. The three most important needs of the security agencies in the 21st century include: Finding the solution for the unsolved crimes, solve the crimes at present in faster manner and predicting the future crimes and prevent it. So, the researcher was motivated by the continual perpetuation of crime by group of individual and at the same time escapes the arm of law. They always go by different names, different identity cards, different locations, and different crime patterns. This is possible as there is no crime profiling and predicting system in existence for instance the just concluded Nigerians Presidential and National Assemble election conducted on the 25th of February 2023 it was observed with a lot of crime and irregularities which if there is such online crime system, it would have been very much easier for the general public to send notification to the security agencies in charge for proper action to this effect, the study aim at providing an enhanced crime system using internet of things (IoT) technologies providing an online accessibility for users remotely which will be allow easier to analyze the existing crime recording system in Nigerian security agencies, provide faster means of tracking, reporting and monitoring of crime and criminalities on real time and facilitate quick response and easy decision making by authorities. The significance of this study is not only based on delivering enhanced technological gadgets or smart systems for our security agencies to track crime, report and capture crime events, though monitoring of crime by these security agencies and instance reporting to the government and organizations cannot do without intelligent systems and with this, controlling the resources of a nation, state or community to avoid wastage of precious time is very much paramount to ensure that quick and automatic responses are achieved without human manual operation. The significance of this study can never be overemphasized, as its importance to the entire world with the following points: Store criminal case reports and provide fast and remote access by authorities, provide instance signal to the society when there is crisis through the SMS cloud alert system, improve security of life and property and encourage further development and research by generating and storing data on the study. This work focuses on the adoption of an IoT technology to design and implement an enhanced crime system using internet of things (IoT) technologies with the integration of an online crime report receiving and storage detected which is responsible for sending alerts to the stakeholder concerned through an online channel for quick and instance notification to police authority, crime visualization module which was able to store the detected crime in a repository and then visualizes it through a web-based interface from user web browser and lastly the crime prediction module for crime

predictions through the analysis of high volume of crime data.

II. LITERATURE REVIEW/RELATED STUDIES

A crime can be characterized as any conduct that is against the letter or spirit of the law [7]. Or, to put it another way, crime as well as legitimacy are social conceptions that are dynamic and alter through time. As stated by [7], there are many various kinds of crimes, from crimes against people to crimes without victims, from violent crimes to white collar crimes. A significant area of sociology is the investigation on criminal behavior and vice, with a focus according to who initiates what kinds of crimes or even why.

2.1 Types of Crime

According to [7], there are many different sorts of crime, from attacks on individuals to crimes without a victim, from violent crimes to white collar crimes. The different criminal offenses and their justifications are listed below:

- Crimes against Persons: Murder, severe assault, rape, and robbery are examples of crimes against people, usually referred to as personal crimes.
- Crimes against Property: Burglary, larceny, auto theft, and arson are examples of property crimes that entail the stealing of goods while causing physical injury. Members of traditionally disenfranchised communities have a greater likelihood to be jailed for these offenses than others, similar to interpersonal offenses.
- Hate Crimes: Violations involving people or property perpetrated in the name of preconceptions against such a person's race, gender, gender identification, belief, handicap, sexual preference, or heritage are known as hate crimes.
- Crimes against Morality: Due to the absence of a complaint or victim, offenses against morals are sometimes known as victimless crimes. Victimless crimes include prostitution, unlawful gambling, and the use of drugs.
- White-Collar Crime: People with high social status who commit violent crimes in the course of their employment are said to be committing "white-collar" crimes. Included in this are insider trading, tax evasion, embezzlement (extorting money from someone's company), and many other earnings tax law offenses.
- Organized Crime: Usually including the distribution and sale of unlawful products and services, criminal activity is done by well-organized groups. Whenever individuals consider of criminal organizations, most frequently think of the Mafia, although the term can also refers to any organization that regulates significant criminal businesses (such as the drug trade, illegal gambling, prostitution, weapons smuggling, or money laundering).

2.2 Internet of Things (IOT)

An interconnected network of hardware (computers, sensors, and machines) and software (applications) that collaborate to automated and optimize operations is known as the Internet of Things, or IoT. [8]. In contrast, [9] categorized the Internet of Things (IoT) as a phrase used to describe a group of technologies that allow exchange of information between multiple devices that are connected to one another through a communications network. This network exchanges information and commands across the internet while also gathering, recording, and managing data to power the functionality of connected devices.

According to [10], users' occupations have become easier with the advent of computers, notably in the area Operators now have it easier to do tasks thanks to computers, especially when it comes to crucial and dangerous tasks. Several computers being connected to each other in order to interact and exchange resources marked the beginning of the development and engagement of the internet. The World Wide Web was created as a result of the internet's evolution, making it feasible for mobile devices to communicate and share resources from far-off areas like a number of crucial and dangerous activities. The creation of handheld devices and the advent of the internet made it simple for the vast majority of the population to begin using computers and the internet, which led to the rapid growth of software programs to address a variety of problems.

According to the notion of the internet of things (IoT), which is a new technology, the aspect of

connecting objects (computers, electronic devices, and equipment) brought about the concept [10].Social media exploded and became the talk of the town thanks to the Internet of Things (IoT), which brought together people of all sizes and from different places to make it simpler to share knowledge and thoughts [6].

2.2.1 Architectural Design Internet of Things (IOT)
In this study, four (4) distinct levels of an IoT technology are described in order to reveal the design and architecture of an IoT as described by [11]: Application layer, management service layer, sensor layer, gateway and network layer, and layer.

2.3 Empirical Studies
From a study by [12] carried a study on the automatic crime reporting and immediate response system. The scholars identified the different forms of crimes that are happening every day in different regions. Huge number of these crimes goes unreported either because there is no law enforcement in the region or people are sometimes scared to reveal their identity to the police. Also, crime goes unreported, because people don't have enough evidence to help police with the investigations. In order to address this problem, this study proposes an automatic crime reporting and immediate response system that is developed based on system integration which combines Raspberry Pi, Microsoft IoT, mobile application and web application. An automatic crime reporting, and immediate response system does not only guarantee informer's safety and secrecy, it also stops cases and reports from being deleted or removed and guarantees information integrity.

According to [13], carried a study on Intelligent Mobile Application for Crime Reporting in the Heterogenous IoT Era. The study uses the surveillance mobile app installed on the smart phone which can be launched at will to start video streaming and sending this to the centralized monitoring server, which in turn sends to the police authority for action. [14]Worked on Tracking Criminal Events through IoT Devices and an Edge Computing Approach, the occurrence of criminal and terrorist activities is one of the biggest problems which is afflicting the current society. In this regard, their paper proposes a solution which aims to enhance the communication and collaboration among citizens and police forces. It is based on an IoT app which exploits the edge computing approach to face with the above mentioned gaps. On the vain, [14] worked on detecting and tracking criminals in the real world through an IoT-based system. Criminals and related illegal activities represent problems that are neither trivial to predict nor easy to handle once they are identified. The aim of the study was to enable the communication and collaboration between citizens and Police Forces (PFs) in the criminal investigation process by combining app-based technologies and embracing the advantages of an Edge-based architecture in terms of responsiveness, energy saving, local data computation, and distribution, along with information sharing. The proposed model is shown below:

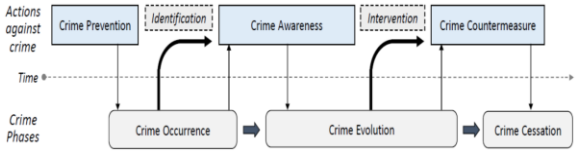

Figure 1: The proposed system of crime detecting and tracking of criminals in the real world through an IoT-based system [14].

According to [15] worked on a Crime analysis using data mining techniques and algorithms. The scholar stated that crime analysis is a methodological approach for identifying and analyzing patterns and trends in crime. With the increasing origin of computerized systems, crime data analysts can help the Law enforcement officers to speed up the process of solving crimes problems by application of data mining where huge amount of crime data stored in warehouses are used for prediction for fast decision making.[16] worked on a study on Survey of Analysis of Crime Detection Techniques Using Data Mining and Machine Learning Data mining is the field containing procedures for finding designs or patterns in a huge dataset, it includes strategies at the convergence of machine learning and database framework.[17]Present a study on an IoT-based Surveillance system. The study reported that crimes have long been a nerve-racking ordeal to pursue a remedy, not just for the government but also for the whole community. According to [18] presented a study on an IOT-Based Architecture for Crime

Management in Nigeria, crime and criminal activities have impacted negatively on the socioeconomic development of Nigeria over the years. The purpose of their study is to develop a framework of Internet of things and Big Data technologies to track and monitor crime and criminalities real-time online in order to reduce crime rate in Nigeria.

In summary, having reviewed some related studies on this paper, the researchers was able to identify some research gap which the current study tends to fill, which includes: Unavailability of mobile link for instant reporting crime within the city of Owerri Municipal council and that of Imo State at large. The current method of reporting case has been on a manual process where the reporter or citizen must visit the close law enforcement agent to do so. The study of [12] presented a study on an IoT-based Surveillance system which was only applicable in india which the mobile application is increasing at a rapid rate in India, the scholars designed this application so as to reduce the crime rate and provide safety measures and awareness among the society of people who are thinking of committing a crime. The work of [16] proposed a system on analysis of crime detection techniques using data mining and machine learning data mining, their study was able to apply data mining as its technology which uses patterns from a dataset to make decision from the patterns received. But looking at our current state of government strategies and plans, most times what the people needs is what they can see and use as long as it can provide instant result for them. Our government finds it difficult to implement plans especially when it has to do with data and patterns. The research gap in the study is that most studies uses data mining algorithm for the modeling of the crime predicting and alert system, while those that uses IoT technologies was not provided a platform for the citizens to report crime accidents as the occur, therefore this study tends to close the research gap in the aspect of proposing and designing an online crime reporting platform which could allow the citizens post crime or suspected crime cases instantly.

III. ADOPTED METHODOLOGY

The study adopted an object oriented analysis design methodology (OOADM) to ensure a proper technical approach for analyzing and designing the proposed system, and also to ensure that the application of an object-oriented programming concept, as well as using visual modeling throughout the development life cycles to foster better stakeholder communication and product quality. The prediction and alerting of future crime trends involves tracking crime rate changes from one year to the next. In the aspect of producing an advanced model that could help both the law enforcement agencies in Nigeria track crime and for the general public to report instantly any witnessed crime, there is need for a system that could grant such access and produce instant and physical structure. An IoT sensor model with an integration of the software application has been one of the fastest growing tools for physical and intelligent response to events which crime reporting and monitoring is one of those. Nevertheless, the proposed IoT based crime system was designed following the OOADM stages /approach: Object-Oriented Analysis, Object-Oriented Design and Object-Oriented Implementation.

3.1 System Analysis

In system analysis, prevailing situation of problem is carefully examined by breaking them into sub-problems.

3.1.1 Analysis of the Existing System

The existing system of crime reporting and handling by our security agencies has been an issue that requires immediate action. The rate of insecurity and killing of innocent souls in our dear country without our law enforcement agencies and security agents not having a clue on the situation of the cases requires an unprompted attention by our government and the general public to assist in fighting crime. Crime are reported by those who fall victim of it, meaning that if one is not a victim, there is no way he/she could help in making sure that the crime and the perpetrator is brought to book. During crime reporting, the victim must visit any police station, where he/she will be asked to write a report on what really happened after which the victim (reporter) might be asked to pay a given sum of money before the reported crime could be given the required attention. Before all these processes are completed, days or weeks might have been passed which the perpetrator of the crime might have escaped.

More so, the law enforcement agency (Police Force) track or monitors crime victims through police patrol search process wasting more time trying to identify the perpetrators of the crime and their location. The diagram showing the analysis of the existing system is shown in figure 2 below:

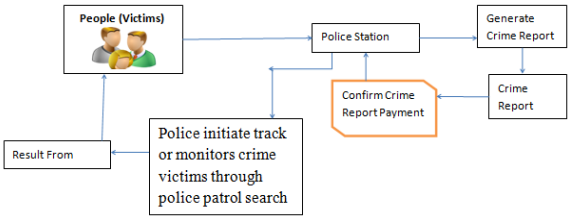

Figure 2: Diagram showing analysis of existing system

3.1.2 Analysis of the Proposed System
The proposed system analysis followed the three OOADM approaches which are in phases:

Phase 1: Object-Oriented Analysis: By looking at the functional requirement of the system by application of unified modeling language tool (UML) to create use case diagrams. The use case diagram describes the actors that are found in the crime system using an IoT technology. Each use case is described in details with diagrams in their respective module section. These use case diagrams model the desired behavior of the system. The Functional requirement is categorized in three (3) main modules:

1. General Public User Requirement Module
2. Police Force User Requirement Module
3. Administrator User Requirement Module

1. General Public User Requirement Module: For a crime to be reported by the general public and for instant notification of the reported crime to get to the security agencies at nearest location, there should be an interface which will allow the public to have access to with immediate response. Once the link is clicked, the user could fill in the location of the crime, nature of the crime, pectoral nature of the crime and persons involved in the crime. Shown in Figure 3 below:

- Report crime
- Locate security agent
- Delete Files
- Upload (Attach) Files

The General Public User Requirement Module can be transformed into the following use case diagram as shown Figure 3.

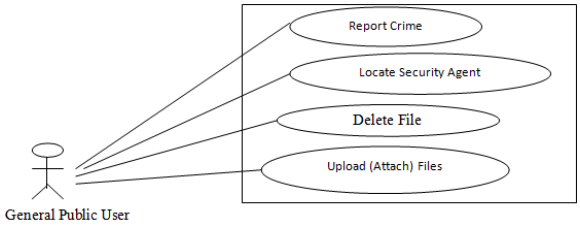

Figure 3: Use Case Diagram of General Public User Module

2. Police Force User Requirement Module: Instant notification of crime alert are received by the police force agency which means there is need to responds to the crime alert notification as it comes. This user module requirement will grant access to only the police force agent with his/her identification number (ID). The operations of the agent is to view crime alert logs as they come in and immediately respond to it either by moving into action, reinforcing the team by alerting other security agents aside from Nigerian police force, register crime cases. The use case diagram below illustrates various activities required by the police force on the platform.

- View Crime Alert Logs
- Delete Records
- Notify Police authority patrol vehicle for urgent action
- Update Records
- Download (Attach) Files

The Police Force User requirement analysis module can be transformed into the following use case diagram as shown Figure 4 below:

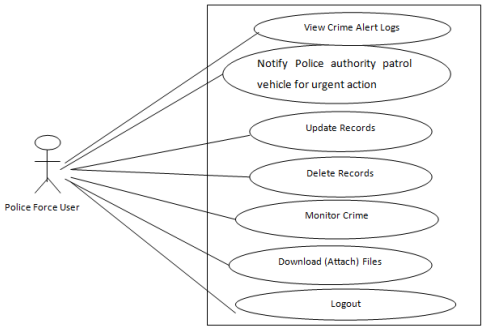

Figure 4: Use Case Diagram of Police Force User Requirement Module

3. Administrator User Requirement Module: Administrator module is the module that enables administrators to configure and maintain various variables in the system. This module will allow administrators to configure general information and assign user role to other users. The administrator can: Open New Account, Register New Crime, Register Police Force Members, View All Crime Alert Logs, Block or unblock account, Trace fraud and Grant Privilege to various user.

System user with administrator role is the user with super user role to the entire crime alert system. This category of user will have the full administrative access rights to each module in the system. The administrator is the "gatekeeper" of the proposed system who creates user profiles for the system and is responsible for restricting the access to other users. The administrator can add as many users as needed and he/she is the key person who will assign user to different role of the system. The Administrator Module requirements analysis can be transformed into the use case diagram as shown in figure 5.

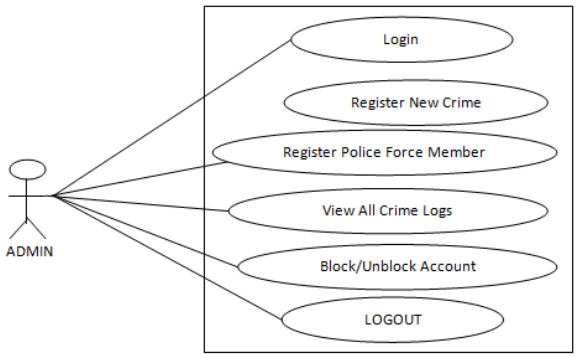

Figure 5: Use Case Diagram of Administrator Module

3.1.3 Summary of the proposed system analysis

The analysis of the proposed system talks at the operation of the enhanced crime system. The system has three different users namely: general public, police officers and the administrator. For any person to report any crime, he/she must visit the platform with any communicable device that is supported with the internet, on getting to the platform, the user will click on a button “Upload/Report crime which will open up a form where the person can enter the details of the suspected crime witnessed or even upload the crime if any imagery file is captured then click on send. Once the crime reporting is successfully done, the person will receive a success message as a confirmatory notification. The police officers user account must have access to the platform through a login link which must undergo a validated before proceeding to the dashboard. The dashboard allows the police user to view crime report cases, monitors crime reports and instantly notify police authority patrol vehicle for urgent action, once the notification is successfully done, it will be store in the database for data documentation for future review and forecast. The administrator user is a user with a high role on the platform, the user has access to check and monitor the activities of other users on the platform by carrying out the registration of new police force member and also registration of new crime into the database and updating other sub-module function of the platform. From figure 6 below, one could understand that the three users have different privileges on the platform and reporting of crime is now made easy and accessible by all general citizen of the country. All report are stored in the Distributed database management system which all police force agents have access to login through their ID. The ID must be verified before access.

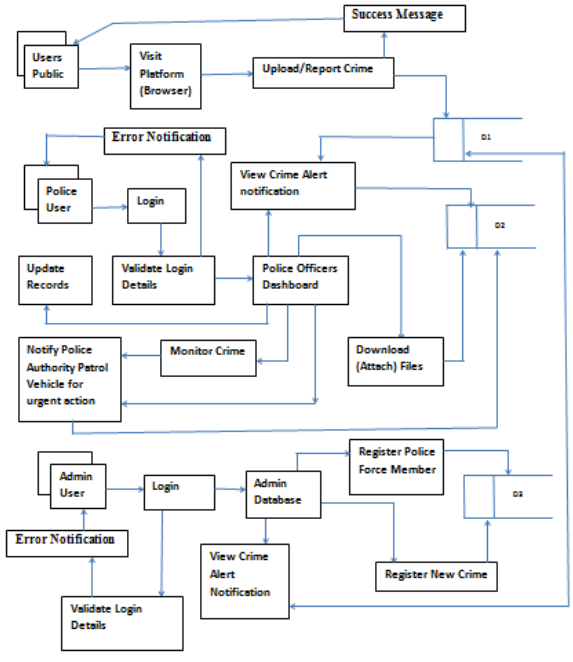

Figure 6: Analysis of the proposed system

3.1.4. High Level Model of Proposed System

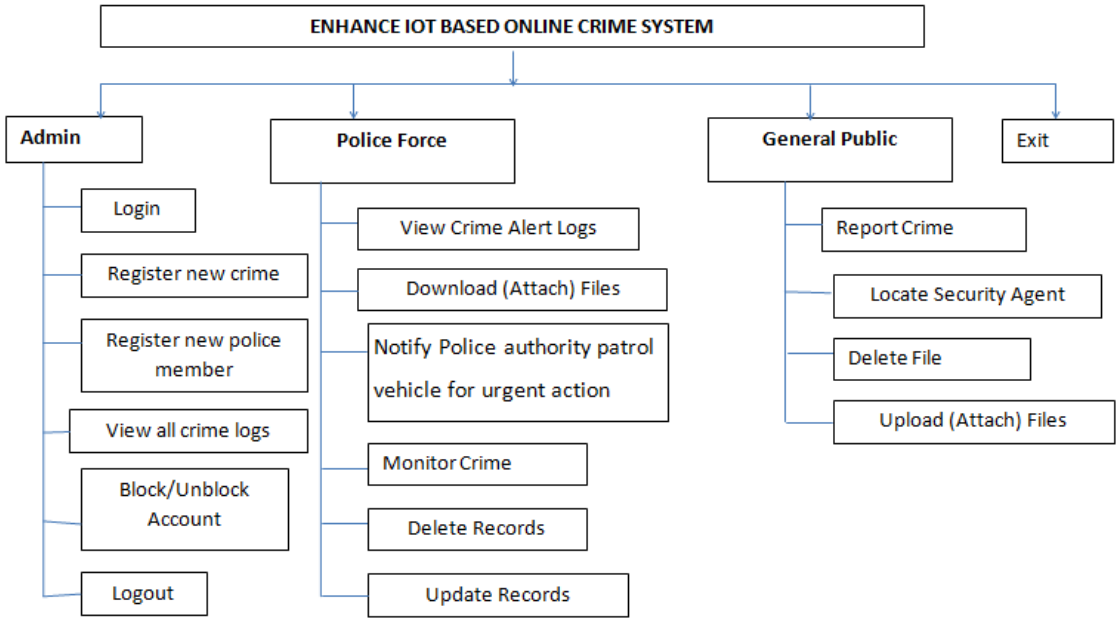

Figure 7: high level model of proposed system

IV. RESULTS

The results was a system that allow the general public make report on a crime, and also allow the police force easily track and monitor a victim of crime through the help of the general public free and accessible link of reporting crime. The benefit of the proposed system that actually makes it different from the existing one is summarized as follows:

1. The proposed application is comparatively cheaper to develop when comparing it with the existing systems, this is because it was developed using open source platform, which is free to use. Most existing ones was developed using a proprietary platform, visual studio.net that is a paid license platform of development. Also in terms of simplicity and flexibility in usage, this is a system to be reckoned with and that can help by easily notification alert
2. The proposed application is simply convenient in easily tracking and locating criminals. This was confirmed during the testing stage when deployed online and lastly, this automated system will help in facilitating the record keeping of criminals for future references and if finally adopted, will make it difficult for criminals to escape authority. This is because; the picture taken by the reporting person will help in the fast and easier identification of the criminals together with the location of the accident.

Figure 8: Account Signup for users: This will enable end users to create an account with their details which will enable them have access to the platform.

Figure 9: Login Platform for users

This interface will enable end users to login with the correct combination of password and username which must be the users email address before an access could be granted.

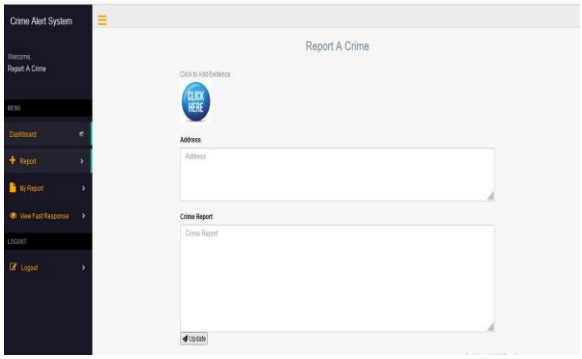

Figure 10: Report Crime scene: This enables any user to report the crime witnesses and at same time upload the picture of the crime for easy identification by the law enforcement agencies.

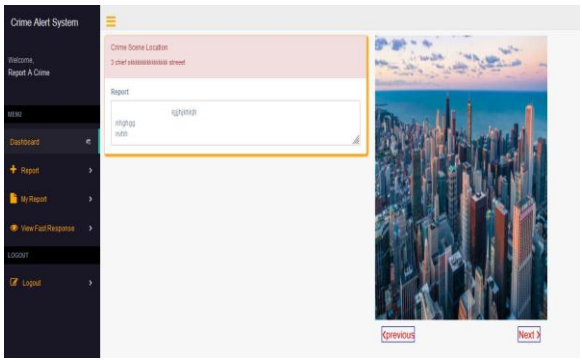

Figure 11: Detailed explanation of the reported crimes: This will enable the reported crime to be fully identified and understand and provide a close meaning and clearer view of the crime reported by the reporter.

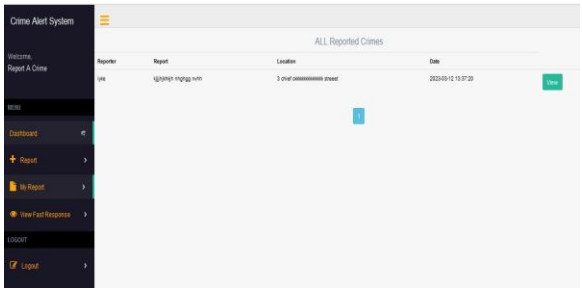

Figure 12: Showing all the reported crime from various respondents and reporters.

CONCLUSION AND RECOMMENDATION

As earlier stated, that the aim of this work is to design an enhanced crime system using internet of things (IoT) technologies. Looking at the current Nigerian system of administration, both public and private management of organizations and processes especially in the security sector involving Police, Army, Navy, and air-force etc, once could found out that there is huge gap on the aspect of security management and tracking of life's and property and hence there is need to automate a capable system that will aid in such activities effortlessly.

The researcher therefore recommends the following:

1. Most law enforcement agencies especially the Nigerian Police force should adopt and apply this new technology in other to provide and render stress free service which will help the capturing and easy reporting of crimes remotely

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